

The Determinate Value of the Medial Clear Space For Deltoid Integrity In Lateral Malleolar Fractures: A Correlative Analysis of Arthroscopic and Radiographic Findings

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STATEMENT OF PURPOSE

The reliability of the radiographic medial clear space (MCS) as a criteria for treatment of displaced lateral malleolar ankle fractures remains unclear. This study aims to establish a reliable plain film MCS threshold that more accurately predicts deltoid integrity. The accuracy of the Lauge-Hansen classification system as a predictor of deltoid injury was also evaluated.

METHODOLGY

The deep deltoid ligament was assessed arthroscopically by a single surgeon on 144 consecutive isolated lateral malleolar fractures during definitive fixation. Partial tears were classified as ruptures. Fractures were classified by the Lauge-Hansen system based on non-weightbearing digital radiographs of the injured ankle captured before splint immobilization and/or closed reduction. The MCS was measured on pre- and post-operative ankle mortise radiographs via digital calipers on Philips PACS® image viewing system at 3 different points (Figure 1) by a single reviewer blinded to the arthroscopic finding (Figure 2).

MCS values were averaged, rounded to the nearest half millimeter, and compared to results of arthroscopic inspection (intact vs ruptured) using Fisher's exact test. Correlative indices were established for each incremental millimeter of MCS widening to determine the predictive value for rupture. Multivariate logistic regression was performed to identify independent risk factors for a ruptured deep deltoid ligament. Wilcoxon rank-sum test was used to compare continuous variables such as patient age, preoperative MCS, and post-operative MCS based on deep deltoid ligament integrity. Patient demographics were also reviewed.

LITERATURE REVIEW

When the fibula is fractured in the absence of medial ankle injury, the deltoid ligament maintains the talus beneath the tibial plafond and prevents changes in tibiotalar contact area (1-6). Specifically, the deep deltoid ligament limits external rotation of the talus, along with lateral translation and anterior displacement (2,4,6-9).

Patients with isolated lateral malleolar fractures treated without surgery demonstrate favorable long-term outcomes (6,10-12). Treatment decision-making in such injuries is based on the MCS, yet the prognostic value of this radiographic finding remains uncertain. Historically a MCS >2-3 mm has been thought to represent deltoid ligament rupture (13-15). A more recent study correlated arthroscopic and radiographic MCS measurements to show that deltoid ligament integrity was uncertain at an MCS of 4-6mm (6).

Recent work has correlated MCS measurements with both cadaveric models and clinical outcomes. In one study ankle specimens had both a lateral malleolar osteotomy and release of deep deltoid ligament, were vertically loaded, and MCS did not change compared to unaltered cadaveric ankles (16). A randomized trial of patients with stress positive isolated lateral malleolar ankle fractures who underwent either conservative or surgical treatment demonstrated no differences in complication rates, functional outcome scores, or time to healing (17). These studies call into question the reliability and utility of MCS measurements for decision-making in the treatment of patients with an isolated lateral malleolar fracture. Other studies demonstrate that the majority of patients with isolated lateral malleolar fractures are stable injuries (18, 19).

RESULTS

The most sensitive MCS measurement for predicting an intact deep deltoid ligament was ≤3mm (98.2%, p-value <0.0001). Figure 3 depicts diminishing sensitivity based on increasing MCS value, each with a p-value<0.0001. Figure 4 correlates MCS with deltoid ligament integrity.

Six patients (11%) with deep deltoid ligament ruptures had MCS measurements ≤3.5 mm. Eleven patients (12.5%) with an intact deep deltoid ligament had MCS measurements >5.5mm, whereas 25 patients (46.3%) with deep deltoid ligament rupture had MCS measurements <5.5mm.

The most notable finding for deltoid ligament integrity based on the Lauge-Hansen classification scheme was that 2 of 10 patients with PER injuries had an intact deep deltoid ligament.

Table 1 depicts descriptive data. Women with a ruptured deep deltoid ligament were older (mean age 64.5) than those with an intact deep deltoid ligament (mean age 49.8). This was statistically significant (p-value=0.0007). Rupture status and age for men did not have a statistical association (p-value=0.82).

Table 1. Summary of Results

	Overall N=144	Deltoid Intact N=88	Deltoid Ruptured N=54
Demographics:			
Age: Mean (range)	44.7 (16-86)		
Sex, N (%)			
Male	86 (59.8%)	47 (52.2%)	39 (72.2%)
Female	58 (40.3%)	43 (47.8%)	15 (27.8%)
Deltoid Ligament Integrity Characteristics			
Medial Clear Space: Mean (Range)		4.2 mm (2.1 - 7.2 mm)	6.4 mm (1.7 - 14.9 mm)
Lauge-Hansen Classification, N (%)			
SER-2	74 (51.4%)	62 (70.4%)	12 (22%)
SER-4	52 (36%)	19 (21.6%)	33 (61%)
PER-3,4	10 (7.0%)	2 (2.3%)	8 (14.8%)
PAB-3	3 (2.1%)	2 (2.3%)	1 (1.9%)

Figure 1. Ankle radiograph MCS measurement method



Figure 2. Same patient, arthroscopic image: deep deltoid ligament intact

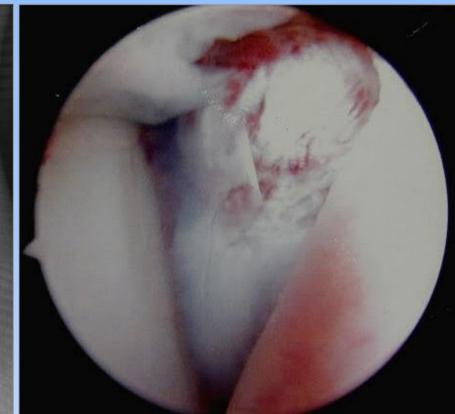


Figure 3. MCS Sensitivity for Deltoid Integrity

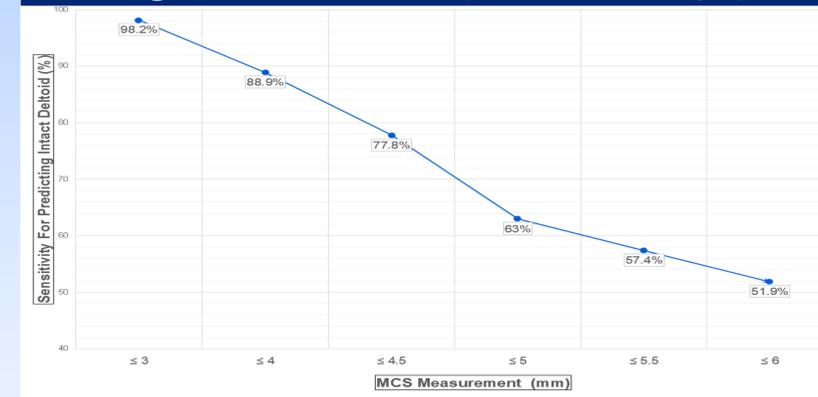
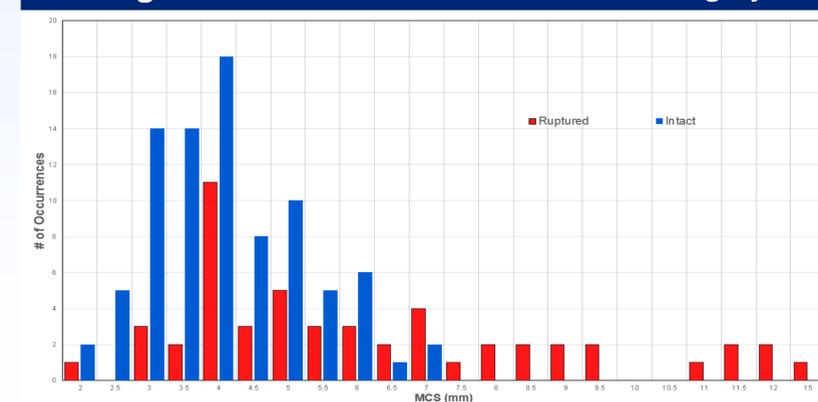


Figure 4. MCS Measurement & Deltoid Integrity



ANALYSIS & DISCUSSION

The results of this study show that MCS measurements between 3-7 mm cannot accurately determine deltoid ligament injury (Figure 4). This broad range of uncertainty suggests that the most common radiographic sign of medial ankle instability is unreliable. In fact, the deep deltoid ligament was more often intact for MCS measurements in the range of 4-6 mm, almost twice as often as it was ruptured. While the MCS is most accurate at ruling out deltoid rupture at ≤3mm (98.2% specificity), patients with MCS measurements up to 7 mm could have a stable lateral malleolus fracture. This study also shows the Lauge-Hansen system to be an unreliable predictor of deltoid injury: 4 patients with pronation patterns and 19 patients with presumably unstable supination-external rotation patterns had an intact deltoid ligament. These results echo the findings of a similar study on smaller patient population, though the MCS range for an intact or ruptured deltoid ligament was more narrow (4-6 mm) and only 3 patients exhibited unexpected findings according to Lauge-Hansen (6).

Study limitations include potential errors in radiographic magnification, MCS measurement technique, arthroscopic assessment, and inherent variations in baseline patient MCS value prior to injury.

With increased attention to the evaluation of isolated lateral malleolar fracture stability, the results of this study highlight the challenges of assessing the significance of medial clear space widening on ankle injury radiographs.

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